# CloudSat Mission Status & Plans

5 June 2019

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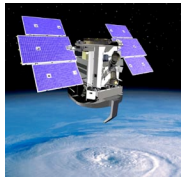
# Mission Status



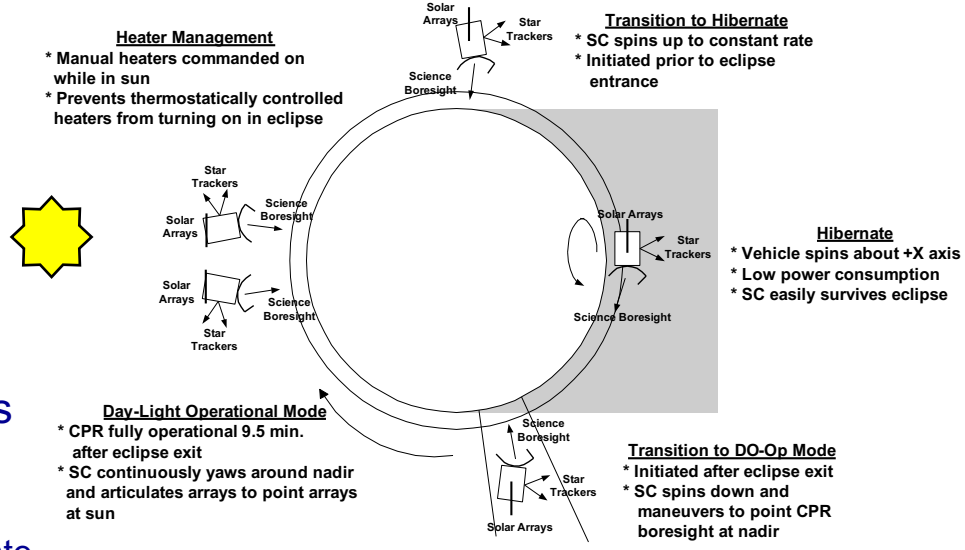
***CloudSat celebrated 13 years in Orbit on 28 April!***

## Daylight Only Operations (DO-Op)

- Due to power restrictions

## S/C Health/Redundancy Status

- CPR is fully redundant
- April 2011 Battery Anomaly
  - June 2011 Left A-Train
  - May 2012 Rejoined A-Train
- May 2011 Receiver #1 Probable Loss
  - Locked up at an off-nominal frequency
  - May be recoverable, however recovery attempts have been unsuccessful to date
- Loss of redundancy on catbed heater mats (no impact to operations)
  - Thruster #1 (2011) & Thruster #2 (2014)
  - Thruster #3 (2018)
- June 2017 Reaction Wheel #1 Failure
  - Triggered CloudSat A-Train Exit Criteria
  - February 2018 Left A-Train




## C-Train Formation

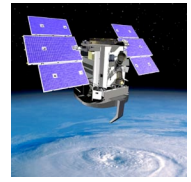
- Flying ~45 sec behind CALIPSO

## Consumables

- Battery - Gentle Charging Techniques
- Fuel – Sufficient for several more years

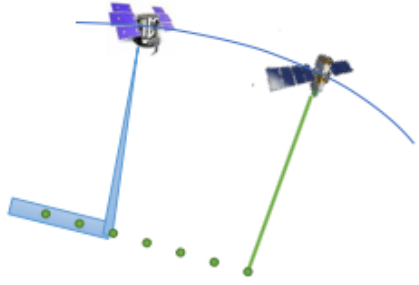
# Operations History

*(Since the last MOWG)*



## Maneuver History

- 3 Orbit Raises
- 3 Orbit Lowers
- 1 Inclination Increase



## Maneuver History – Un-planned Maneuvers

- 2 COLA Maneuvers (1 raise / 1 lower)

## Data Outages

- Solar Eclipse:  6 Jan 19 - 46 Orbits of CPR data lost
- Recovery Mode:  13 April 19 - 213 Orbits of CPR data lost

## Contingency OOH Training conducted in February 2019

- Was well attended at the RSC, where we have some new personnel

## Battery Charging

- Refined KI Boost durations
- Umbra Entry & Exit CBM timing adjustments to reduce charge spikes

## Other

- Hip Hop Trials (1 orbit / 24 hour)

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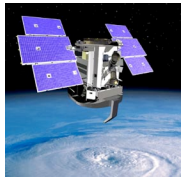
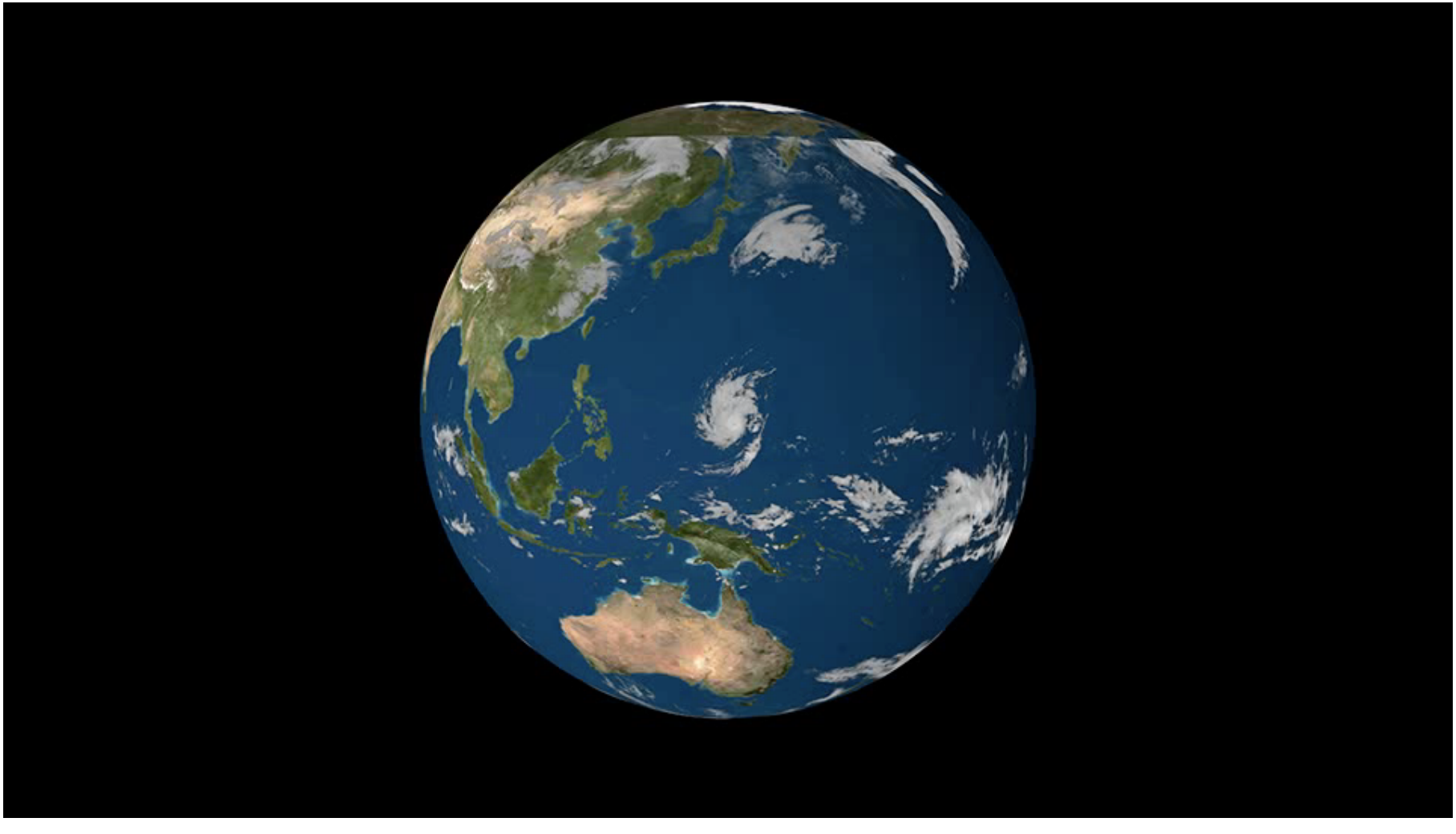
A NASA EARTH SYSTEM SCIENCE PATHFINDER MISSION

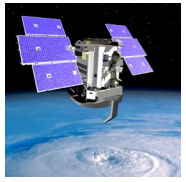
# CloudSat Overflight of Typhoon Wutip





# Risks & Concerns

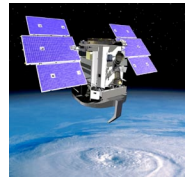
*(Since the last MOWG)*



## Communication Outages With Kirtland Air Force Base

- Automated Data Distribution System (DDS) outages to Colorado State (CIRA) and the Constellation Control System (CCS) have plagued the team much of April – May 2019
  - ✓ Mitigation: Robust back-up file delivery capabilities developed for both paths
  - ✓ Mitigation: Detailed De-Brief to be conducted at Kirtland on 25 June
  - ✓ Mitigation: Long term mitigation is TBD

# Future Plans



## CloudSat will continue science operations with CALIPSO the C-Train

- The spacecraft continues to operate nominally in Daylight Only Operations (DO-Op)
- Power margins remain positive, although watching CPR stability heater on time
- A study to modify DO-Op to increase solar heating of the cold side of the spacecraft, thus decreasing the stability heater on time (Hip-Hop) is underway

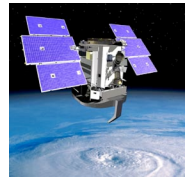
## Continue coordination with the A-Train Constellation and participation in Mission Operations Working Group (MOWG) meetings

- Regular twice monthly tag-ups with CALIPSO
- Formation flying maneuvers will consist primarily of orbit lowers

## Automation of USAF RSC ground station previously delayed due to the A-Train Exit & C-Train Formation will likely not be implemented in the future for CloudSat Mission Operations

- Phase 1: Automated State of Health (SOH) Checking
- Phase 2: Automated Downloads of Data Storage Unit (DSU) and Solid State Recorder (SSR) Data
- Phase 3: Automated Uploads of Daily & Weekly Command Sequence Memory (CSM)

# Summary



**CloudSat has been flying with CALIPSO in the C-Train since October 2018**

- CloudSat is flying ~35 seconds behind CALIPSO

**The spacecraft is healthy and is operating nominally in DO-Op**

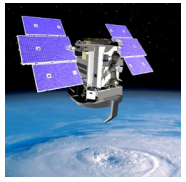
- Gentle charging techniques have improved the health of the battery
- Fuel is sufficient for several more years
- A reliable, no-reaction-wheel capability to execute orbit burns in the event of another reaction wheel failure has been proven

**CloudSat could operate through 2023. Likely suspects for ending the mission are:**

- Reaction wheels – the remaining 3 reaction wheels are getting old, but there is no increased friction observed to-date.
- Battery capacity -- Hip-Hop, when implemented, will increase the minimum voltage, and gentle charging has improved battery performance.

**Will propose again at the next call for NASA Senior Review Proposals**

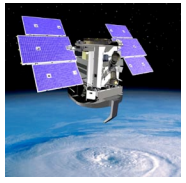
- Expect the ”call” for proposals to be received in December 2019
- Proposal will be due the first week of March 2020



# Back-Up

# Risks & Concerns

*(Ongoing)*

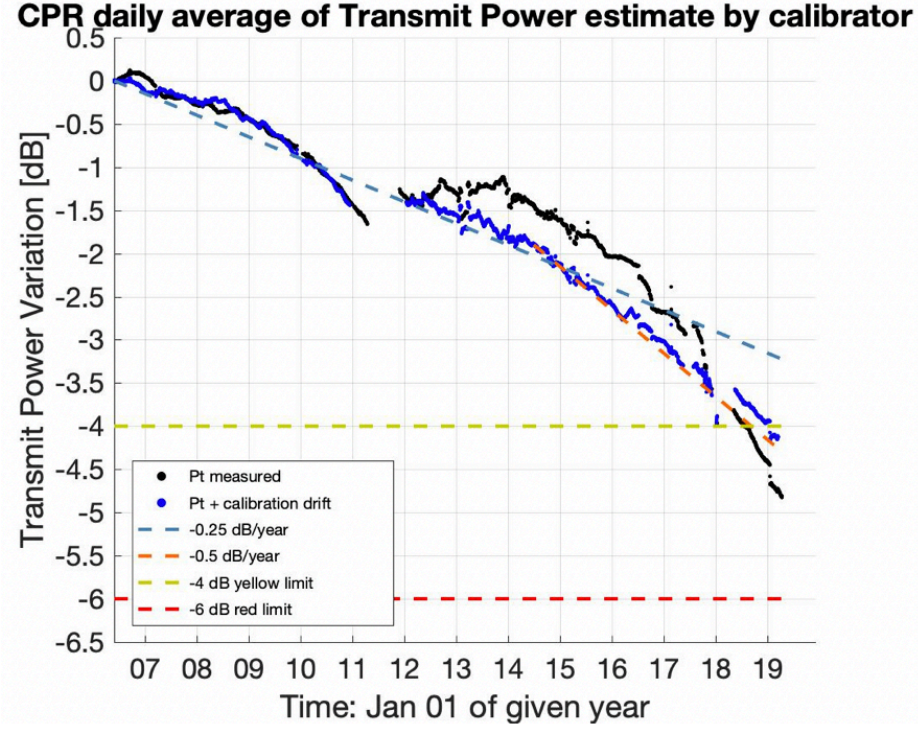


## CPR EIK Degradation Risk

- As the CPR ages, we will eventually reach the-24dBZ sensitivity threshold
  - ✓ Mitigation: Switch to the backup CPR HPA (EIK & HVPS)

## CPR Continues to Operate with Full Redundancy

- Yellow Limit is at -26dBZ / Red Limit is at -24dBZ



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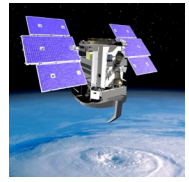

## Reaction Wheel Failure Risk

- An additional reaction wheel failure could threaten/end science mission
  - ✓ Mitigation: Working on 2-Wheel science observation capability
  - ✓ Mitigation: Use thrusters-only to lower CloudSat to graveyard orbit

## Spacecraft Battery Degradation Risk

- Additional battery degradation threatens/ends science mission
  - ✓ Mitigation: Continue to evaluate and implement gentle charging techniques (VT Stepping, KI Boost options have proven beneficial)
  - ✓ Mitigation: Switch to Standby-Mode for 2 month in the summer if CPR stability heater on time increases
  - ✓ Mitigation: Use exit burns to lower CloudSat to the graveyard orbit (can be executed from the lower-power Sun-Point-Spin Mode)
  - ✓ Mitigation: Orbit will naturally begin drifting toward shorter eclipses now

## Spacecraft Computer (SCC-1) Failure

- Failure of SCC-1 would necessitate the switch to the redundant side
  - ✓ Mitigation: Switch to backup SCC-2